dary disturbances of particularly violent type, and hence it is often the parent of tornadoes, which are small compared with the thunderstorm, while it itself is comparatively limited in comparison with greater weather disturbances that affect the circulation over extensive areas. The thunderstorm is the most extensive of local storms, and between it and the dry squalls of wind, local gusts and tornadoes, there are many variations, none of them, however, being anything but secondary disturbances, whirls and eddies in the general circulation.

The cyclone is differentiated from all local storms, whose operations are confined to a comparatively small region, since it is a weather disturbance, at its smallest, on a large scale, and at times reaches a continental magnitude. The name is of technical not popular origin, and was first used by Piddington, an English meteorologist, to describe the tempests of the Bay of Bengal and other tropical waters. It is a descriptive epithet and refers to the almost circular movement of the winds about a common center, then supposed to be the unvarying characteristic of these great and destructive storms that are called typhoons in the Eastern seas, and hurricanes in the Caribbean and West Indian waters. The word has been generalized in meteorology and is used to denote one of the two types of atmospheric eddies into which the circulation of the air in temperate zones is thrown. These are cyclonic and the anti-cyclonic.

The most destructive of all cyclones, and in fact the most destructive weather outbursts known are the tropical cyclones, the so-called typhoons of the Philippines, China Sea and Japanese waters, the hurricanes of the West Indies, and Atlantic and Gulf coasts of the United States. Though the largest tornado rarely has a diameter of a mile, the smallest of tropical cyclones rarely falls below 100 miles in diameter, and its sphere of destructive influence may range from 100 to 600, even to 1,000 miles. As the hurricane now ravaging the West Indies shows, the tropical cyclone may persist for days, traveling thousands of miles. The point of origin for the tempests that visit our coast is the eastern Atlantic in low latitudes. They cross over to the West Indies, recurve in the Gulf of Mexico, over or east of Florida, and then travel to the northeast, along the coast line of the United States, then out into the Atlantic over Newfoundland, sometimes reaching English waters. By that time they have taken on all the characteristics of a cyclone originating in the temperate zone. The destructive effects of the cyclone are the result of the winds that blow in spirally about its center, which in the front of the cyclone may reach any velocity from 60 to 90 miles an hour. The low pressure of the barometer in the center of the storm and the terrific winds lift up a tremendous sea that raises the tides above the normal, and hence through disastrous floods cause great loss to life and property along the low-lying coasts, as has been the fate of the bayou region of Louisiana and the sea islands of Georgia and South Carolina on numerous occasions. The rainfall is also often excessive and destructive.

Differing from the tropical cyclones merely in degree are the continental cyclones of the temperate zone. These are the largest weather disturbances known, but are not necessarily violent. On the contrary, they often represent a mild, vague, general circulation of the winds about a common center, within which area the rainfall may be light, heavy, nearly continuous, or broken up into separate areas. These cyclones—the real cyclones of the American Continent—may have a diameter of from 500 to 1,500 miles, and even larger, thus covering an area of over 1,000,000 square miles. They persist for weeks, and, traveling from west to east, may go two-thirds of the way around the globe. Save when their vortex is contracted to about the size of that met with in tropical cyclones, 50 to 100 miles or so, the continental cyclones are beneficent rather than destructive factors in the general circulation. When such contraction occurs in the fall, winter, or spring over the region of the Great Lakes, or over the Atlantic, the conditions repeat all the phenomena of a coast hurricane, and may cause loss of life and damage to property by reason of the hurricane velocity of the winds, the excessive rainfall, and the heavy weather on the lakes or at sea. From this it must be clear that the confusion of general cyclonic with local storm or tornado conditions, so common in the West is easily avoidable, as the contrasts are marked and the distinctions based on broad differences. The mere fact that a storm is local, of limited extent, no matter how great its violence, is the first proof that it is not a cyclone, though the tendency in the West and South is to apply the technical term "cyclone" to all violent local outbursts, on the mistaken idea that the word "cyclone" means a tornado and a tornado only. Compared with the tremendous size and appalling character of the Porto Rico hurricane and other tropical cyclones of like destructive effects, such as that of St. Vincent and Barbados last year, the tornado at New Richmond, Wis., was of small account and thunderstorm casualties trivial.

NOTES BY THE EDITOR.

EFFECT OF WIND ON CATCH OF RAINFALL.

From a recent article by Mr. Barwick, published in the Sacramento Record Union, it appears that on the average of many years the rain gages in the city of Sacramento show systematic differences.

The Weather Bureau gage was 57 feet above ground during the first part of the record, but 100 feet above during the latter part. It gives a total annual rainfall of 20.30 inches, on the average for twenty-one years.

The railroad gage at the railroad shops, 56 feet above ground, gave a total annual rainfall of 17.02 inches, on the average for thirty years.

S. H. Gerrish's gage at his residence, near the ground, gives 20.83 inches, on the average for twenty-two years.

The respective months differ among themselves very much in the same proportion in all these records.

The railroad gage is located about a mile north of the Weather Bureau, but Mr. Gerrish's gage is about a mile and a half northeast from the Weather Bureau.

Mr. Barwick says:

There is no doubt in my mind but that the greater part of this difference in the railroad gage is due to the shop buildings, which are all mostly constructed of iron and roofed over with the same material. Then the heat from the many engines in, around, and passing through the railroad grounds causes much greater evaporation than takes place at the point of location of other gages mentioned. Then, again, the readings are taken but once a day, and if the rain ceases for several hours before measurements are made, there must be an appreciable evaporation. The railroad gage being near the south end of the building, the wind on reaching the gage passes over it at a greater velocity than were it located in the center of the roof, and as our storms are with southerly winds, it places the railroad gage to the windward of its position as to the building's location.

C. C. Bonte has suggested placing the gage on a pole in the grass plot near the passenger depot, which would take it from a most undesirable location, and place it in one of the best that could be suggested in that locality, being surrounded by grass all the time, which being irrigated in summer, would reduce the evaporation to a much smaller amount than at its present location. The railroad gage and the Weather Bureau gage being of nearly the same elevation during sixteen years, should not show such a great difference as they do, and the effect of a change in location will be looked for with considerable curiosity by those interested in rainfall records.

As the records by the railroad gage are invariably smaller throughout the year than those of either of the other gages, there is some plausibility in the suggestion by Mr. Barwick that this deficit is due to the evaporation that takes place before the rain is measured. This evaporation can be greatly diminished by a better construction of the gage, but at best, is liable to be appreciable in a very dry atmosphere. If the gage at the railroad shops were so located as to be in the lee of a tall building it would catch less by reason of the interference of the building; but this does not seem to be the case. On the contrary, the railroad gage is so placed on the roof near the south end of the building that the wind strikes it with greater velocity than at almost any other location that could have been chosen; therefore, it can not be said that the gage gives a deficit because it is sheltered by a building. The great velocity of the wind at the gage seems to have suggested to Mr. Barwick the idea that there would be also a corresponding amount of evaporation. This is a true cause for a deficit, but it is hardly sufficient to explain the total annual deficit of 3.5 inches, or 15 per cent of the 20.5 inches that ought to have been recorded annually. It would be very easy for the local observer to pour a given quantity of rain water into a gage in this locality and determine, by measurement, how much evaporates every day, and calculate what would be the average amount of evaporation between the close of any rain and the time when the daily measurement is made. The average length of time that elapses is probably less than twelve hours and the greater part of this is at night time when the evaporation is relatively small, so that it ought to be easy to ascertain whether Mr. Barwick's suggested explanation is sufficient.

Mr. C. C. Bonte suggests that the gage be removed and placed in a grassy park that is irrigated through the summer, thereby reducing the evaporation to a much smaller amount than in the present situation. This suggestion is, of course, in keeping with the hypothesis that the deficit in rainfall is really caused by the evaporation of water from the gage. But there are several objections to the removal of the railroad gage to another location: (1) It has not been proved that the deficit is due to evaporation; (2) the new location will also be subject to evaporation and there may, therefore, still be a deficit. (3) Even if the new location showed no deficit due to evaporation, still other sources of error would exist and the removal will simply give us a new series of measurements in a new location without telling us positively anything about the errors of the old situation or giving us any means of correcting the past record so as to obtain something nearer the truth.

The Editor can not too strongly deprecate the idea that a gage that has been used to obtain confessedly imperfect records during the past should be removed to some new location, in the hope of obtaining better records in the future. What the climatologist needs is a correct record, kept for a long time at each station, so as to obtain both normal values and the extreme departures from the normal; this is true both of temperature, rainfall, wind, and all other meteorological elements. When an instrument has been established and its record maintained for many years, it becomes a standard for all the neighborhood, and nothing but the most imperative necessity can excuse the removal to another location. If errors due to location are suspected to exist, other gages should be established and extra records be kept for the purpose of investigating the errors of the first location, and such record should be kept up until we have the data necessary for applying an appropriate correction to the records of the first place and that location should not be deserted until a new and better location has been carefully correlated with the older one, so that the old and new series may be properly combined into normal values.

In the present case, as indeed in every other one that has thus far come under our consideration, there is a much more important matter than evaporation from within the gage to be considered, and that is the effect of the wind at the gage upon the catch of rainfall. This is a matter that has been expounded by various students of the subject for a hundred years past, although probably the first who clearly saw the full importance of the matter were Bache and Henry, in 1845, and Jevons in 1861. A memoir by the Editor, read at Washington in 1887, but first published in full in Bulletin No. 7 of the Forestry Division in the Department of Agriculture, puts the whole matter in a clear and practical way. When there is no wind and the air is full of large and small drops and fine particles of mist and spatter and, perhaps, even light flakes of snow, all settle down vertically to the ground and every rain-gage within a region of a mile or two records the same rainfall. But when a wind is blowing against the side of a gage, the larger particles falling swiftly go into it, while the lighter ones are carried off to one side. In fact, snow flakes may enter the gage and be whirled out again. Under these circumstances the total catch of the gage will depend, primarily, upon the strength of the wind, and secondly, upon the shape or configuration of the gage.

Gages have been invented in which this wind effect is a minimum and, perhaps, even inappreciable, such were those devised by Prof. Joseph Henry of the Smithsonian Institution, in 1853, and by Professor Nipher of St. Louis in 1878. These are called shielded gages. If a slight protection be built up around the gage so that the wind at the mouth of the gage has its force greatly diminished, this is called the "protected" gage, and the observations by Boernstein and by Hellmann are quite favorable to this style. But the arrangement that has long been adopted as the standard in England and Europe is the so-called "pit" gage recommended by Symons. The normal pit gage stands in an open field at the center of a slight depression of a yard or more in radius. The pit is so hollowed out and the earth is thrown up in a circular ridge on the outside of the pit in such a way that, when the gage is set up in the center, the mouth of the gage is on a level with or slightly below the rim of the pit. By this arrangement the mouth of the gage is exposed to only the gentle wind that prevails at the surface of the ground the loss due to wind is small while the spattering of rain into the gage is inappreciable.

For every foot that the mouth of a gage is elevated above the ground, in the free air, the wind becomes stronger and stronger. For lower winds this increase is very nearly in proportion to the square root of the altitude, and the wind effect on the catch of the gage increases in the same ratio, so that if a gage whose mouth is 3 feet above the mouth of the pit gage shows a deficit of 6 per cent in its rainfall, then, one that is 48 feet above will show a deficit of 24 per cent. These are not merely hypothetical figures but those that actually occur, and this ratio will hold good up to 200 feet of altitude, at least in the average rains and winds of America and Europe.

Since the protection of the mouth of the gage from the wind is the most important consideration in obtaining the true rainfall, therefore, one should experiment in this direction, viz, establish a protected gage near the old gage whose records are supposed to be deficient, and determine, after a year or two of comparative readings, what its percentage of deficiency may be for winds of different velocities.

Fortunately, although our Weather Bureau gages are almost invariably placed upon tall flat roofs, yet they are also frequently well protected against the wind effect, especially when they are placed in the middle of a roof having a good parapet wall; if gages are placed too close to the parapet they may give an erroneous record. A tall building or tower with parapet wall is an obstacle in the wind, and the rain that is carried over it is distributed irregularly on the roof. Too little falls on the windward side in the lee of the parapet; too much may fall on the leeward side close to the parapet. Nothing but actual trial and observation can decide at what points on the roof the rain catch represents the normal fall in the undisturbed atmosphere. In fact, it is desirable that several gages should be read regularly so as to determine the distribution of rainfall over the roof for each direction of the wind, and for light and heavy rains or snows. Of course the distribution of snow, as it lies on the roof immediately after a storm, shows at a glance the effect of the wind on it, and by analogy, the relative effect of the wind on the distribution of rain, excepting only that in the case of snow there is a great deal of drifting and rearrangement of the snow particles that does not occur in the case of rain, which cannot be subsequently drifted after having once fallen into the gage.

On the whole, therefore, we must urge upon those who are interested in rainfall that they do not remove their gages to better locations, but that, first of all, they establish a few gages in the neighborhood and actually determine the percentage of deficit appropriate to the location and the peculiarities of the old gage.

Mr. Symons, who has examined hundreds of rainfall stations in Great Britain, finds that many observers have erroneous measuring apparatus, and it is to be hoped that all Weather Bureau observers will see to it that both apparatus and methods are so correct that an error of 1 per cent can not occur systematically.

A copy of the Editor's article "On the determination of the true amount of precipitation and its bearing on theories of forest influences" can be furnished to any observer who desires it.

The large differences between adjacent gages are usually due chiefly to wind effects. Two similar gages set on posts in an open field, the mouths being elevated above ground 1 or 2 and 4, 5, or 6 feet, respectively, give the data for determining approximately the correction to the lower gage, so as to get results approximately free from the wind effect.

If the altitudes are H_1 and H_2 and the corresponding catches C_1 and C_2, then the the true rainfall is approximately

$$R = C_1 + \frac{\sqrt{H_1}}{\sqrt{H_2} - \sqrt{H_1}}(c_1 - c_2) = C_1 + \frac{1}{\sqrt{\frac{H_2}{H_1}} - 1}(c_1 - c_2).$$

Example: $C_1 = 25.50$ inches for $H_1 = 2$ feet, and $C_2 = 23.00$ inches for $H_2 = 6$ feet. Then will $R = 25.50 + 1.366 \times 2.50 = 28.91$. In other words, the lower rain gage, 2 feet above the ground, catches only 88 per cent of what would be caught by a pit gage at the surface of the ground in calm weather. This corresponds to an annual rainfall in the drier portions of our country and to strong winds or small raindrops. When every individual rainfall through the year has been computed in this manner, it may be possible to arrange the deficits in the order of the observed general velocity of the wind and determine the specific influence of feeble and strong winds on small or large raindrops and on snows, and on protected gages as distinguished from those that are freely exposed to the wind.

SEISMOGRAPH STATIONS IN THE UNITED STATES.

We are informed that in 1889, Mr. A. Lawrence Rotch, the distinguished patron of meteorology, purchased and set up at the Blue Hill Observatory, a Ewing-Holden seismograph, as made in San Francisco. During the first year that the instrument was maintained in working order no records were obtained. Recently the Massachusetts Institute of Technology has built a geodetic observatory for educational purposes, in the Middlesex Fells, north of Boston, in an isolated situation, and Mr. Rotch has given his seismograph to the Institute, so that it will now be installed at the new observatory within a few months. A description of this observatory is published in the Technology Quarterly for June, 1899.

We hope that this augurs well for regular seismological work in the United States, a matter that has been much neglected, except possibly in California.

It has always been the custom for meteorological observers, especially those of the Smithsonian system, to record the occurrence of earthquakes. In 1874, the present Editor, in reorganizing and extending the field of the MONTHLY WEATHER REVIEW began the regular publication of earthquake notes, so far as observations were received, and, in 1883, at his request, a joint committee on earthquakes was organized in Washington, by cooperation with the Coast Survey and Geological Survey.

This whole subject is a branch of geo-physics, coordinate with the study of vulcanology, surface geology, meteorology, tides, etc., and is worthy of special recognition. It is to be hoped that the article on the Milne seismograph, published in the MONTHLY WEATHER REVIEW for May, will revive active interest in the subject.

At present the only stations in the United States that are known to keep seismographs of any kind in continuous operation ready for any earthquake that may occur, are the following seven: Washington, D. C., (Weather Bureau, Marvin seismoscope); Middlesex Fells, Mass., (one mile from Malden, Geodetic Observatory, Ewing-Holden seismograph); Cleveland, Ohio, (Prof. E. W. Morley, Adelbert College, Gray seismograph); Lick Observatory, Cal., (Mount Hamilton, Ewing-Holden seismograph); San Francisco, Cal. (Observatory of the Coast and Geodetic Survey, G. W. Davidson, Director, Ewing-Holden seismograph); Mare Island, Cal., (Naval Observatory, Everett Hayden, Superintendent, Ewing-Holden seismograph; latitude, 38° 05′ 55.8″ N.; longitude, 122° 16′ 19.3″ W., on the crest of a hill about 60 feet above mean low water and near the northern extremity of the island; the seismograph is set up on a pier in the transit room); Oakland, Cal., (Chabot Observatory, Professor Burchalter, Ewing-Holden seismograph).

Prof. E. C. Pickering states that a Milne seismograph has been sent by him to his observatory at Arequipa, Peru, and is probably now in operation there. There are also seismoscopes on hand at the Harvard College Observatory at Cambridge, Mass., but they are not in use owing to the proximity of the electric cars.

As the vibrations of the ground caused by the electric cars are quite superficial we hope that Professor Pickering will find a suitable location for observing the genuine earth tremors and that all these stations will kindly send regular reports to the MONTHLY WEATHER REVIEW.

BACK NUMBERS.

Mr. A. Lawrence Rotch, Director of the Blue Hill Meteorological Observatory (post office Hyde Park, Mass.), desires to obtain the following numbers of the American Meteorological Journal, viz: June, July, and August, 1884, of Vol. I; June and July, 1885, Vol. II; September, October, and December, 1886, Vol. III.

TEMPERATURES IN THE SUNSHINE.

In the June report of the Colorado section, Mr. F. H. Brandenburg gives a summary of some observations made at Denver, Colo., by Mr. A. G. Eneas, of Boston, Mass. Mr. Eneas used standard thermometers with black bulbs, placed within a so-called hot box, which was constructed of seasoned pine wood five-eighths of an inch thick. Its dimensions were 9 by 3.5 by 2 inches. The cover was made of two plates of fine crystal plate glass. The inside of the box was stained with bright green water-color paint and then coated $\frac{1}{32}$ of an inch thick with lamp black. The same apparatus had been used by Mr. Eneas in Boston before he made a series of observations for several months at Denver. The greatest difference observed at Boston between the outside air temperature and the interior hot-box temperature was 40° C.. or 90° F. The similar maximum difference at Denver was 98.5° F. This excess may be largely due to the pure air of Colorado or it may be due to various nonmeteorological causes. Such observations are not to be recommended, since it is so easy to do better work.

This form of hot box is one of several methods of illustrating, not measuring, the total radiation of the sun by means of its heating effects. The best form of hot box was that invented by Pouillet, more properly called the pyrheliometer, and was filled with water, which was continually stirred, so that the total amount of heating effect could be more certainly measured by the thermometer. But such apparatus